



**Australian Government**

**Department of the Environment and Energy**

# **Australian Energy Update**

## **2018**

August 2018



# **Australian Energy Update 2018**

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The Department acknowledges the traditional owners of country throughout Australia and their continuing connection to land, sea and community. We pay our respects to them and their cultures and to their elders both past and present.

## Foreword

The way we supply and use energy in Australia continues to change. This includes changes in the type of energy we use, how we use it and where it comes from, as new technologies are adopted, as our economy grows and changes in structure, and as awareness of our energy use and its economic and environmental cost grows.

To help understand these and other changes, to plan for Australia's energy future, and to make sound policy and investment decisions, we need timely, accurate, comprehensive and readily-accessible energy statistics.

The *Australian Energy Statistics* is the authoritative and official source of energy statistics for Australia to support decision making and international reporting, and to help understand how our energy supply and use is changing. It is updated each year and consists of detailed historical energy consumption, production and trade statistics and balances. It includes all types of energy and all parts of the economy.

This edition contains data to 2016–17. This report, the full dataset, and guide are available at <https://www.energy.gov.au/government-priorities/energy-data/australian-energy-statistics>.

This year we have published additional statistics on industrial electricity generation and use of gas in LNG plants, as well as energy sourced from waste.

Feedback regarding the Australian Energy Statistics can be provided to [australianenergystatistics@environment.gov.au](mailto:australianenergystatistics@environment.gov.au).

Energy Statistics and Analysis Section  
Department of the Environment and Energy  
August 2018

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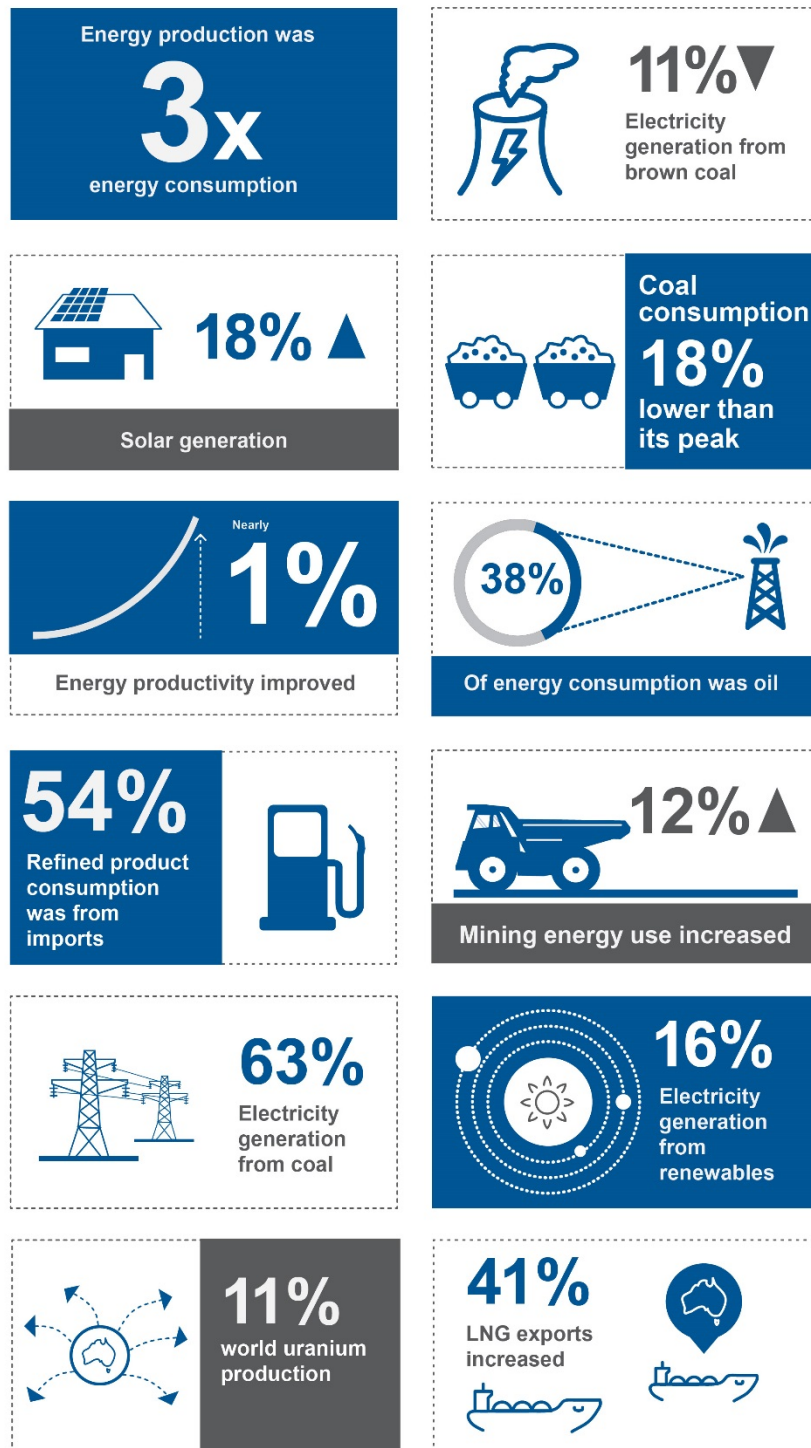
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## Abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
APS	Australian Petroleum Statistics
BITRE	Bureau of Infrastructure, Transport and Regional Economics
BREE	Bureau of Resources and Energy Economics (former)
CSG	Coal seam gas
GWh	Gigawatt hours
GDP	Gross domestic product
IEA	International Energy Agency
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
NGERS	National Greenhouse and Energy Reporting Scheme
NGL	Natural gas liquids
ORF	Other refinery feedstock
OCE	Office of the Chief Economist
PJ	Petajoule
PV	Photovoltaic

## Executive summary

# Australian Energy Statistics 2016–17





## Energy consumption

- The Australian economy grew by 2.0 per cent in 2016–17 to reach \$1.7 trillion. Population grew by 1.7 per cent to reach 24.6 million people.
- Australia's energy consumption rose by 1.1 per cent in 2016–17 to reach 6,146 petajoules. This compares with average growth of 0.8 per cent a year over the past ten years. Growth in 2016–17 was 65 petajoules, the same amount of energy from filling a 55-litre tank of petrol 34 million times.
- Energy productivity (gross domestic product (GDP) divided by energy consumption) improved by 0.9 per cent in 2016–17, and by 17 per cent over the past ten years. Australia now creates \$275 million in GDP for every petajoule of energy consumed, nearly \$50 million more than a decade ago.
- Most of the growth in energy use in 2016–17 occurred in the mining sector, which rose by 12 per cent, mainly because of increased natural gas and electricity consumption to support liquefied natural gas (LNG) exports. Energy use also increased in other parts of the mining sector.
- Transport use grew by 3 per cent in 2016–17, underpinned by higher diesel use in passenger and freight transport and increased use of aviation fuel. Total refined product consumption increased by 2 per cent in 2016–17, and is now nearly three times larger than total electricity consumption.
- Energy use for electricity generation fell by 2 per cent in 2016–17 despite a slight increase in electricity output, due to reduced brown coal use and an increase in renewable generation.
- Energy use in manufacturing continued to fall, by 2 per cent in 2016–17, with the largest declines occurring in chemicals and non-ferrous metals manufacturing sectors, both a result of reduced activity.
- Oil accounted for the largest share of Australia's primary energy mix in 2016–17, at 38 per cent, followed by coal (32 per cent) and natural gas (25 per cent). Renewable energy sources accounted for 6 per cent.
- Coal use fell by 1 per cent in 2016–17, and was 18 per cent below its peak in 2008–09. Increased black coal use was offset by lower brown coal consumption after the closure of Hazelwood and Northern power stations.
- Natural gas consumption grew by 1 per cent in 2016–17. Gas use in LNG plants increased commensurate with higher output, but gas use in most parts of the manufacturing sector fell in 2016–17.
- Renewable energy consumption grew by 5 per cent in 2016–17. The growth was largely driven by bagasse, solar and hydro energy.

## Energy production

- Energy production rose by 4 per cent in 2016–17 to 17,957 petajoules, primarily as a result of increased natural gas production. This outweighed a fall in oil and brown coal production.
- Natural gas production grew by 23 per cent in 2016–17, underpinned by increased coal seam gas (CSG) production in Queensland for LNG exports. Coal seam gas accounted for one-third of Australian gas production and nearly two-thirds of east coast gas production in 2016–17.

- Black coal production was relatively steady, while brown coal output fell by 8 per cent, reflecting less demand for brown coal-fired electricity.
- Crude oil and condensate production continued its longer term decline, falling by 12 per cent in 2016–17, despite increased liquids production from new gas fields in the west.

### Electricity generation

- Electricity generation in Australia rose marginally in 2016–17 to 258 terawatt hours (929 petajoules). This figure includes all electricity generation, including industrial, rooftop solar PV and off-grid generation.
- About 12 per cent of Australia’s electricity was generated outside the electricity sector by industry and households in 2016–17.
- Brown coal-fired generation fell by 11 per cent in 2016–17, while black coal rose by 4 per cent, with the share of coal remaining at 63 per cent of total generation. The share of coal fell to 61 per cent in calendar year 2017.
- Australia is now less reliant on coal than at the beginning of the century, when coal’s share was more than 80 per cent of electricity generation.
- Natural gas-fired generation was fairly steady in 2016–17, remaining at about 20 per cent of total electricity generation. Its share increased slightly in calendar year 2017, to 21 per cent of total generation.
- Renewable generation increased by 6 per cent in 2016–17, contributing 16 per cent of total generation. Most of the growth was from solar in 2016–17, but growth also occurred in hydro. Generation from solid waste and landfill biogas was 3 per cent of total renewable generation.
- Renewable generation declined slightly in calendar year 2017, to 15 per cent of total generation, with a fall in hydro in the latter part of the year. Hydro accounted for 5 per cent of total generation in 2017, while wind accounted for just under 5 per cent. Solar accounted for 3 per cent of total generation in 2017 and the majority of this was small-scale PV.

### Energy trade

- Most of Australia’s energy production is exported. Net exports (exports minus imports) were equal to two-thirds of production in 2016–17.
- Energy exports grew by 4 per cent in 2016–17 to 14,140 petajoules. LNG exports grew by 41 per cent to 2,865 petajoules, as new capacity in Queensland and Western Australia came online. In contrast, exports of black coal and crude oil fell by 3 per cent and 8 per cent respectively.
- Australia is also a significant exporter of uranium oxide, for use in nuclear power plants overseas. Uranium exports fell by 5 per cent in 2016–17 to 7,081 tonnes.
- Energy imports increased by 2 per cent to 2,327 petajoules in 2016–17. Most imports are of refined petroleum products and crude oil. Domestic refineries imported three-quarters of their feedstock, while over half of refined product consumption in Australia was met by imports.

# 1. About the Australian Energy Statistics

The *Australian Energy Statistics* (AES) is the authoritative and official source of annual energy statistics for Australia. It provides information designed to increase the understanding of energy supply and use in Australia, to support decision making in government and industry, and to meet annual international energy reporting obligations. The dataset also underpins the calculation of Australia's greenhouse gas emissions from energy supply and use.

The AES provides detailed energy consumption, production and trade statistics and balances, by state and territory, by energy type and by industry, in energy content and physical units. Where possible, the data is compiled and presented using concepts and definitions intended to align the AES with the framework used by the International Energy Agency (IEA).

Key data sources include facility level reporting from the National Greenhouse and Energy Reporting Scheme (NGERS), the *Australian Petroleum Statistics* (APS), the *Resources and Energy Quarterly*, datasets and estimates from other Australian and state government agencies, internal estimates using statistical techniques, and public company reporting. Some datasets from private subscription services and industry associations are also used to compare with these estimates and sources.

The AES has been published by the Department of the Environment and Energy (2017 to present), the Department of Industry, Innovation and Science (2015 and 2016), the Bureau of Resources and Energy Economics (BREE) (2012 to 2014), the Australian Bureau of Agricultural and Resources Economics and Sciences (ABARES) (1989 to 2011), and various previous Australian government agencies, since the mid-1970s.

The full AES dataset is made available through tables in Excel format at <https://www.energy.gov.au/government-priorities/energy-data/australian-energy-statistics>. A list of the AES tables available on the website is provided in Table 1.1.

The AES is accompanied by this report, the *Australian Energy Update*, which highlights recent trends in Australian energy consumption, production and trade.

The *Guide to the Australian Energy Statistics* is designed to assist users in better understanding the AES and to increase the transparency of the dataset. It contains information on the publication tables, definitions and concepts, data sources and methodology, conversion factors, confidentiality and historical revisions.

The main unit in the AES is the petajoule (PJ). One petajoule =  $1 \times 10^{15}$  joules. One petajoule, or 278 gigawatt hours, is the heat energy content of about 43,000 tonnes of black coal or 29 million litres of petrol. A car using 6.7 litres of petrol per hundred kilometres could drive approximately 436 million kilometres on one petajoule. One petajoule is equivalent to filling up a car with a fuel tank capacity of 55 litres of petrol around 532,000 times.

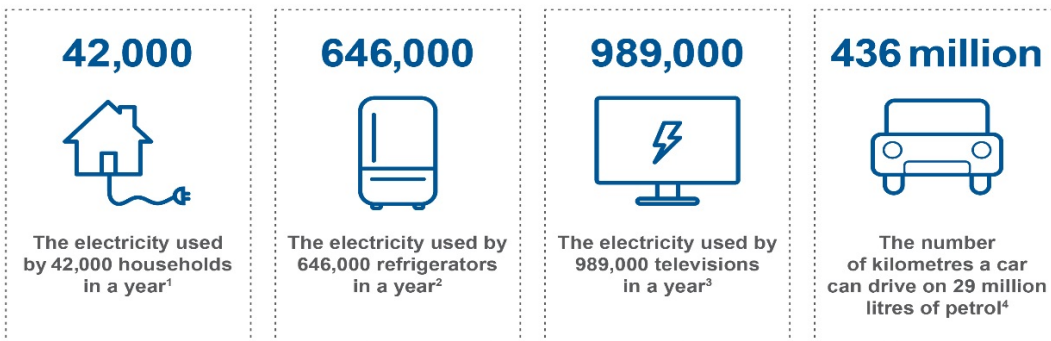
Table 1.1: 2018 Australian Energy Statistics tables

Table name	
Table A	Australian energy supply and consumption, energy units
Table B	Australian energy consumption indicators, by state, energy units
Table C	Australian total primary energy consumption, by state, by fuel, energy units
Table D	Australian total primary energy consumption, by state, by detailed fuel, energy units
Table E	Australian total net energy consumption, by state, by industry, energy units
Table F	Australian energy consumption, by state, by industry, by fuel, energy units
Table G	Australian energy consumption, by state, by fuel, physical units
Table H	Australian total final energy consumption, by fuel, by industry, energy units
Table I	Australian production of primary fuels, by state, physical units
Table J	Australian energy supply and trade, by fuel type, energy units
Table K	Australian energy consumption, by state, by industry, selected fuels, energy units
Table L	Australian consumption of electricity, by state, physical units
Table M	Australian energy imports, by fuel type, physical units
Table N	Australian energy exports, by fuel type, physical units
Table O	Australian electricity generation, by state, by fuel type, physical units
Table P	Australian consumption and production of coal, by state, physical units
Table Q	Australian consumption and production of natural gas, by state, physical units
Table R	Australian production of natural gas, by type and state, energy units
Table S	Australian production and exports of uranium, physical and energy units

## One petajoule (PJ) explained

The joule is the standard unit of energy in general scientific applications. One joule is the equivalent of one watt of power radiated or dissipated for one second.

**One petajoule is 10<sup>15</sup> joules (1 million billion) or 278 gigawatt hours.**



<sup>1</sup>The average home uses approximately 24 gigajoules of electricity in 2016–17  
<sup>2</sup>A typical 2.5 star fridge uses 430 kWh of electricity per year  
<sup>3</sup>A 48 inch 4.5 star label television uses 281 kWh of electricity per year  
<sup>4</sup>A car consuming 6.7 litres of unleaded petrol per 100 kilometres

## 2. Energy consumption

Energy consumption measures the amount of energy used in the Australian economy. It is equal to domestic production plus imports minus exports (and changes in stocks). It includes energy consumed in energy conversion activities (such as electricity generation and petroleum refining), but excludes derived or secondary fuels (such as electricity and refined oil products) produced domestically to avoid double counting of energy. It can be referred to as total net energy consumption and is also equal to total primary energy supply. Further detail is provided in Department of the Environment and Energy (2018) *Guide to the Australian Energy Statistics*.

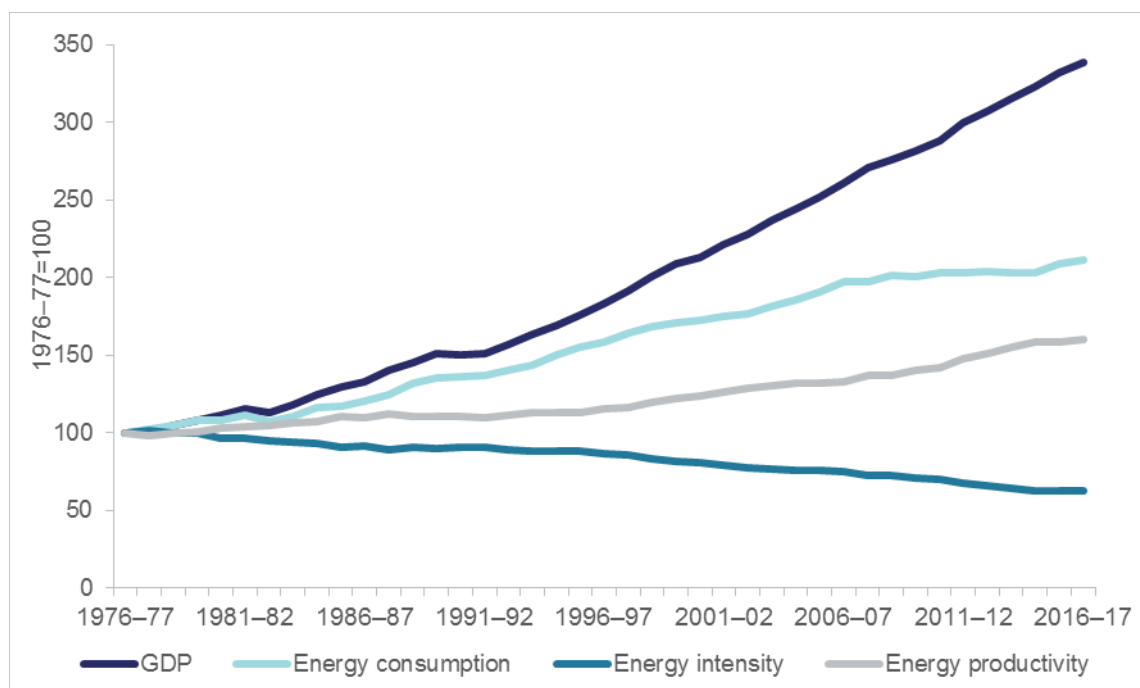
Energy consumption rose by 1.1 per cent in 2016–17 to 6,146 petajoules, its highest ever level. This compares with average growth of 0.8 per cent a year over the past ten years. Growth in 2016–17 was 65 petajoules, the same amount of energy from filling a 55-litre tank of petrol 34 million times.

In 2016–17, the Australian economy grew by 2.0 per cent to reach \$1.7 trillion. The Australian population grew by 1.7 per cent to reach 24.6 million people.

### 2.1 Energy productivity

The relationship between energy use and economic output can be described in terms of the energy intensity, or inversely, the energy productivity, of the Australian economy. Energy intensity measures the amount of energy used to produce a unit of economic output (energy consumption/GDP), while energy productivity measures the amount of economic output produced per unit of energy input (GDP/energy consumption).

Figure 2.1: Australian energy intensity and energy productivity



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table B

As economic growth in Australia over recent decades has generally outpaced growth in energy consumption, the Australian economy has tended towards lower energy intensity and higher energy productivity over time (Figure 2.1).

This reflects cumulative improvements in energy efficiency as well as a shift in the Australian economy away from highly energy-intensive industries such as manufacturing towards less energy-intensive industries such as services. Increased use of renewable energy instead of fossil fuels for electricity generation has also had a positive impact on energy productivity.

Energy productivity improved by 0.9 per cent in 2016–17, after being flat in 2015–16. Energy productivity has improved by 17 per cent over the past ten years. Australia now creates \$275 million in GDP for every petajoule of energy consumed, nearly \$50 million more than a decade ago.

## 2.2 Energy consumption, by fuel type

Fossil fuels (coal, oil and gas) accounted for 94 per cent of Australia’s primary energy mix in 2016–17. Oil, including crude oil, liquefied petroleum gas (LPG) and refined products, accounted for the largest share of energy consumption, at 38 per cent in 2016–17, slightly higher than the previous year (Table 2.1). This figure includes domestic and imported crude used by Australian refineries, and imported refined products used by industry and households, but nets off refined products produced domestically to avoid double counting of energy.

Oil consumption increased by 2 per cent in 2016–17, with the increased consumption of refined products, mostly for transport, partially offset by a decline in crude consumption by refineries.

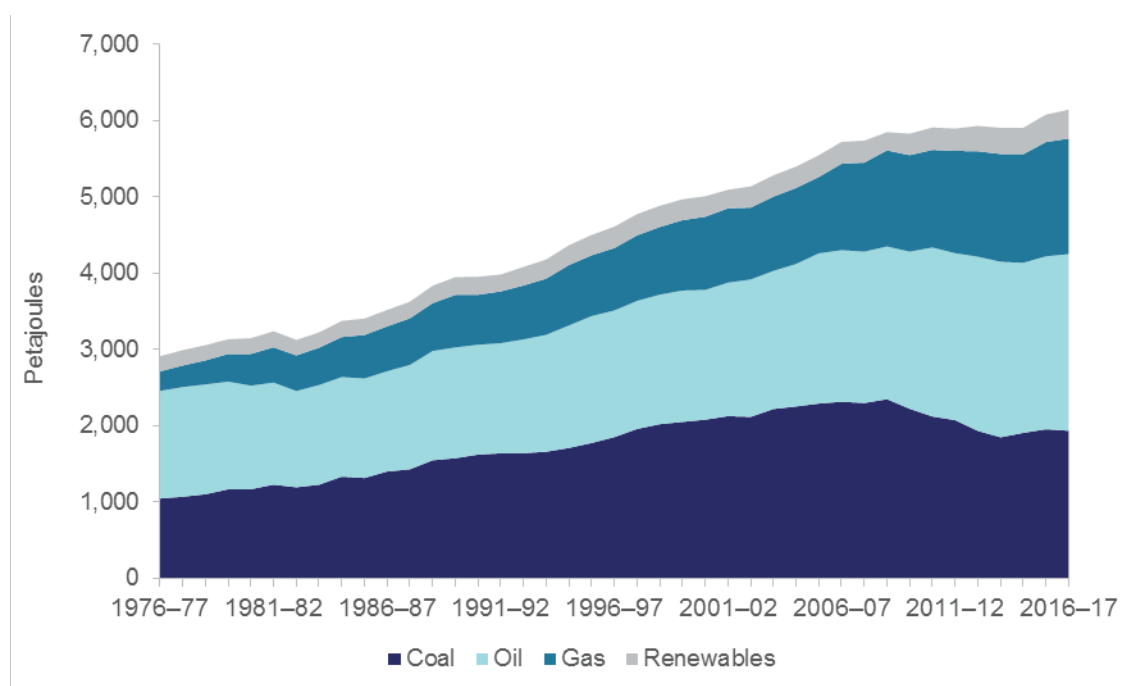
Table 2.1: Australian energy consumption, by fuel type

	2016–17		Average annual growth	
	PJ	share (per cent)	2016–17 (per cent)	10 years (per cent)
Coal	1,936.9	31.5	-1.0	-1.9
Oil	2,315.4	37.7	2.1	1.7
Gas	1,515.0	24.7	1.1	2.9
Renewables	378.7	6.2	5.3	3.2
<b>Total</b>	<b>6,145.8</b>	<b>100.0</b>	<b>1.1</b>	<b>0.8</b>

Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table C

Coal remained the second largest fuel consumed in 2016–17, accounting for 32 per cent of energy consumption (Figure 2.1). Coal consumption fell by 1 per cent in 2016–17, reversing the growth of the previous two years, and returning to the declining trend observed over the past decade. The decline in 2016–17 was caused by a large decline in brown coal consumption after the closure of the Hazelwood and Northern power stations, which more than offset an increase in black coal used for electricity generation.

Figure 2.2: Australian energy consumption, by fuel type



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table C

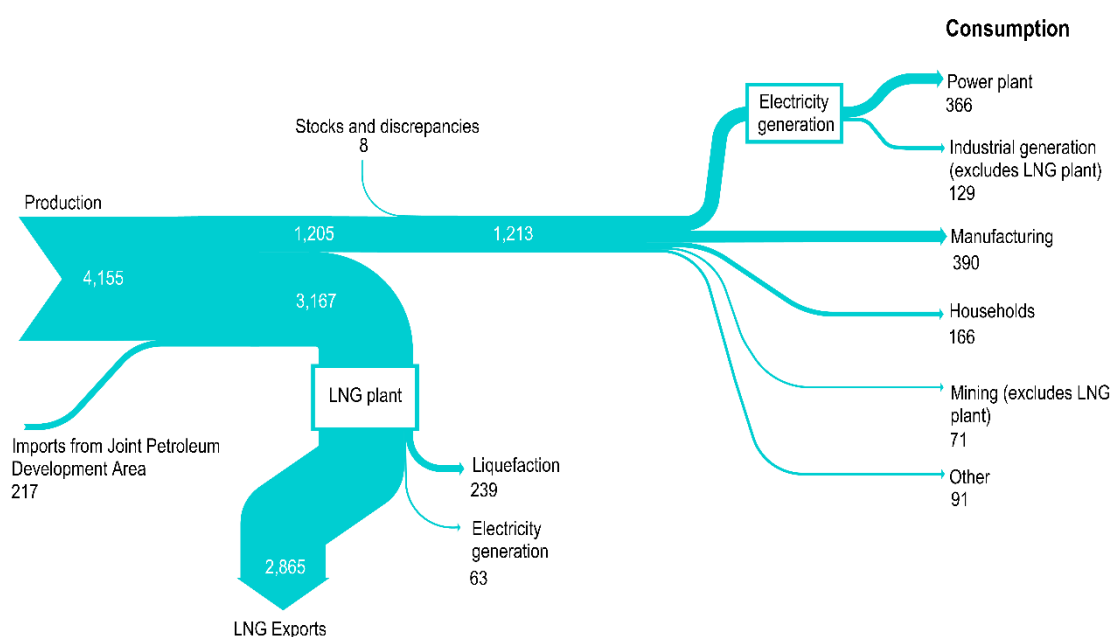
Australia's coal consumption in 2016-17 was 18 per cent lower than its peak in 2008-09, when its share of the energy mix was around 40 per cent. Brown coal consumption in 2016-17 was around 24 per cent lower than in 2008-09. This partly reflects the closure of twelve coal-fired power stations in the five years to 2016-17.

Natural gas accounted for 25 per cent of energy consumption in 2016-17. Gas consumption rose by 1 per cent in 2016-17, with increased use in mining in Queensland and Western Australia to support the expansion of LNG exports. In LNG production, around 9 per cent of gas flows are consumed by the plant during liquefaction, with the remainder exported as LNG. Gas is also used at the LNG plant to generate electricity, which is included in the electricity generation sector in the AES. In total, LNG plants accounted for approximately one-tenth of Australian gas consumption in 2016-17 (Figure 2.3).

In contrast, a decline in gas consumption in 2016-17 was observed in the manufacturing sector, including in petrochemicals, chemicals and plastics. This reflects reduced activity in the sector, with an increase in industrial gas prices also potentially affecting gas consumption.

Around 37 per cent of Australia's gas consumption in 2016-17 was for electricity generation. Of the gas used for electricity generation in Australia, about one-third is used for generation by industry. This includes electricity generation at smelters, refineries and mine sites. It also includes some unprocessed natural gas used to generate electricity during the gas production process. This consumption is included in the electricity generation sector in the AES, which allocates gas consumption to the activity of generating electricity, rather than to the original industry such as mining.

Figure 2.3: Australian natural gas flows, petajoules, 2016–17



Note: Gas used at LNG plants for liquefaction and electricity generation is included in total gas consumption in the AES, but has been disaggregated in this figure.

Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Tables A and F and internal sources

Renewable energy sources accounted for the remaining 6 per cent of Australian energy consumption in 2016–17, comprising mainly biomass, hydro and wind energy. This includes renewable energy use for electricity generation, as well as direct use of renewables such as firewood for residential heating, bagasse use in manufacturing and solar hot water.

In 2016–17, renewable energy consumption rose by 5 per cent, mainly underpinned by growth in bagasse, solar and hydro energy (Table 2.2). Consumption of bagasse, the remnant sugar cane pulp left after crushing, rose to 29 per cent of total renewable energy use in 2016–17, reflecting increased tonnage in sugar cane production.

Use of hydro rose by 6 per cent and wind by 3 per cent in 2016–17. Hydro energy has been a feature of Australia’s electricity mix for decades, and production fluctuates from year to year according to market and weather conditions.

Wind and solar energy have exhibited rapid growth in the past decade. Wind power has increased an average of 17 per cent per year since 2007–08 to 45 petajoules in 2016–17. Solar PV has grown from less than 0.5 petajoules a decade ago to 29 petajoules in 2016–17, including growth of 18 per cent last year.

Municipal and industrial waste can be used to generate electricity, and provided nearly 3 petajoules of energy in 2016–17, up from 0.4 petajoules five years ago. Landfill biogas provided a further 12 petajoules of energy in 2016–17.



Table 2.2: Australian renewable energy consumption, by fuel type

	2016–17		Average annual growth	
	PJ	share (per cent)	2016–17 (per cent)	10 years (per cent)
Biomass	205.4	54.2	5.0	-0.2
- wood, woodwaste, sulphite lyes	95.1	25.1	1.9	-0.4
- bagasse	110.3	29.1	7.9	-0.1
Municipal & industrial waste	2.6	0.7	0.3	na
Biogas	15.0	4.0	-4.1	3.7
- landfill gas	12.2	3.2	-6.5	na
- other biogas	2.8	0.7	8.0	na
Biofuels	7.1	1.9	-5.3	5.3
- ethanol	6.4	1.7	3.4	na
- biodiesel	0.6	0.2	-48.7	na
Hydro	58.6	15.5	6.3	3.4
Wind	45.3	12.0	3.3	16.9
Solar PV	29.1	7.7	18.0	59.2
Solar hot water	15.7	4.2	5.7	10.0
<b>Total</b>	<b>378.7</b>	<b>100.0</b>	<b>5.3</b>	<b>3.2</b>

Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Tables D, F, O

### 2.3 Energy consumption, by sector

The electricity supply, transport and manufacturing sectors accounted for nearly three-quarters of Australian energy consumption in 2016–17 (Table 2.3).

The electricity supply sector accounted for 28 per cent of energy consumption in 2016–17 (Table 2.3). Energy consumption in this sector (including fuel inputs to electricity generation, own use and losses) declined by 2 per cent during this period, despite slightly higher electricity output. This reflects reduced brown coal-fired electricity generation and an increase in renewable generation.

When measuring primary energy consumption, a change in coal-fired electricity generation has a greater effect than a change in some renewable generation such as wind, solar and hydro, because these renewables are only measured when turned into electricity. For example, if wind generation rises by 1,000 gigawatt hours, then energy consumption would rise by 3.6 petajoules, because the electricity generated is measured. If coal-fired generation rises by 1,000 gigawatt hours, then energy consumption would increase by the amount of coal consumed to generate the electricity, which would be around 10 petajoules (assuming an efficiency of 35 per cent).

Transport also accounted for 28 per cent of Australian energy consumption in 2016–17. Increased energy use across all forms of transport resulted in a 3 per cent increase in transport energy consumption in 2016–17 (Table 2.4). Most of the growth was in diesel consumption for passenger and freight use, supported by steady economic and population growth, and switching to diesel

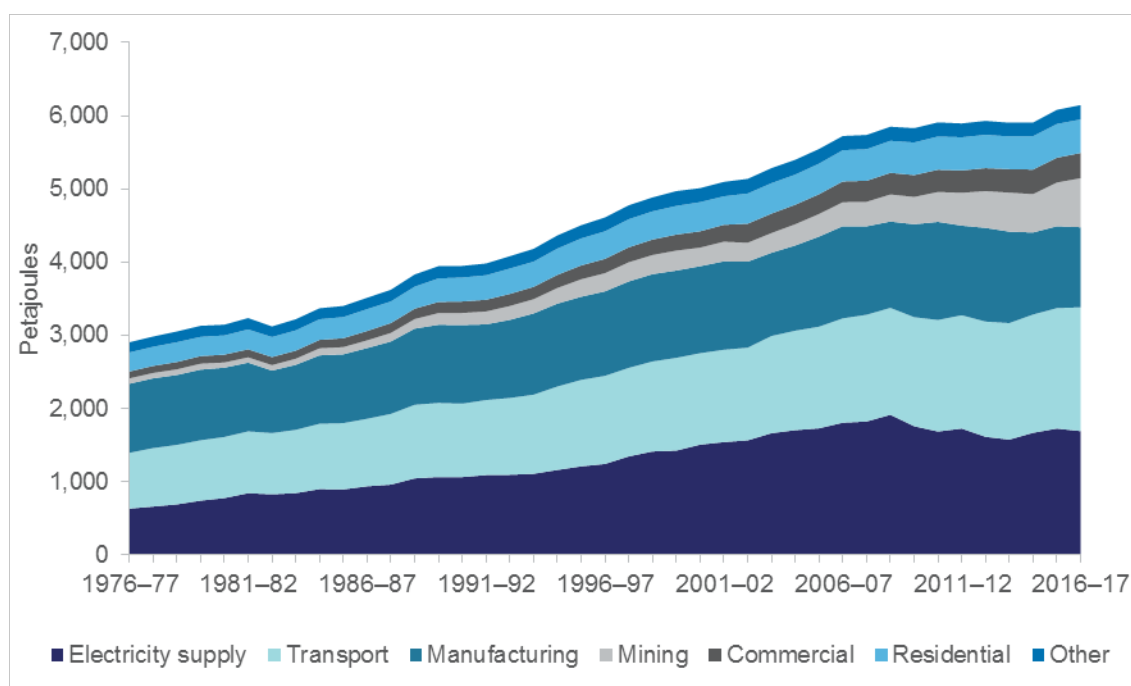
vehicles (Figure 2.5). The diesel vehicle fleet has doubled since 2010, to 4.5 million vehicles in 2018, while petrol vehicle registrations increased by only 7 per cent over the same period (ABS 2018a). Road transport accounted for nearly three-quarters of transport energy consumption in 2016–17.

Table 2.3: Australian energy consumption, by industry

	2016–17		Average annual growth	
	PJ	share (per cent)	2016–17 (per cent)	10 years (per cent)
Electricity supply	1,692.7	27.5	-2.0	-0.8
Transport	1,691.5	27.5	2.8	1.7
Manufacturing	1,093.7	17.8	-2.1	-1.1
Mining	669.0	10.9	11.8	8.0
Residential	458.4	7.5	-0.5	0.7
Commercial	344.6	5.6	1.7	2.0
Agriculture	116.3	1.9	5.9	2.3
Construction	24.2	0.4	-0.8	-1.0
Other	55.5	0.9	-5.9	-3.1
<b>Total</b>	<b>6,145.8</b>	<b>100.0</b>	<b>1.1</b>	<b>0.8</b>

Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table E

Figure 2.4: Australian energy consumption, by sector



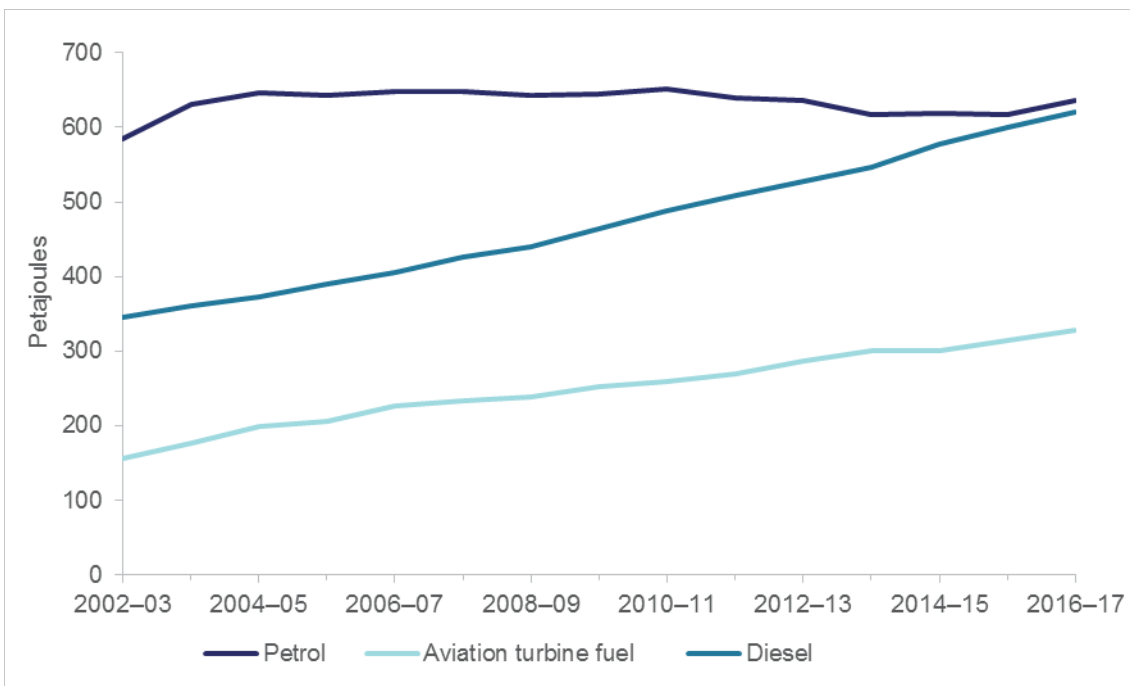
Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table E

Table 2.4: Australian transport energy consumption, by subsector

	2016–17		Average annual growth	
	PJ	share (per cent)	2016–17 (per cent)	10 years (per cent)
Road	1,218.2	72.0	2.4	1.4
Air	330.7	19.6	4.8	3.8
Rail	61.7	3.6	2.4	4.3
Water	49.3	2.9	1.6	-4.3
Other	31.5	1.9	2.7	0.6
<b>Total</b>	<b>1,691.5</b>	<b>100.0</b>	<b>2.8</b>	<b>1.7</b>

Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table F

Figure 2.5: Australian transport energy consumption, by major fuel type



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table F

Air transport accounted for a further 20 per cent of transport energy use in 2016–17. Consumption of aviation fuels increased by 5 per cent in 2016–17, mainly due to international air transport growth.

Energy consumption in the manufacturing sector fell by 2 per cent in 2016–17, continuing the declining trend in recent years (Table 2.5). Chemicals manufacturing saw the largest absolute decline in energy use, consistent with reduced activity. An increase in energy use in non-ferrous metals in Western Australia was more than offset by declines in energy consumption in Queensland and Victoria attributable to the closure of the Queensland Nickel refinery and to output at the Portland Aluminium refinery being reduced for an extended period by a power fault.

Table 2.5: Australian manufacturing energy consumption, by subsector

	2016–17		Average annual growth	
	PJ	share (per cent)	2016–17 (per cent)	10 years (per cent)
Non-ferrous metals	341.8	31.3	-2.2	-1.9
Chemicals	195.1	17.8	-4.0	0.3
Food, beverages, tobacco	164.4	15.0	2.1	5.0
Ferrous metals	121.8	11.1	3.8	-4.4
Petroleum refining <sup>a</sup>	81.7	7.5	-5.3	0.2
Wood, paper and printing	62.9	5.7	1.1	-1.5
Cement	54.8	5.0	-5.9	-3.1
Other	71.3	6.5	-10.9	-3.6
<b>Total</b>	<b>1,093.7</b>	<b>100.0</b>	<b>-2.2</b>	<b>-1.1</b>

Notes: <sup>a</sup> Energy consumption in petroleum refining equals total energy consumption minus derived fuel production. The derived fuel production is netted off to avoid double counting of this energy in other sectors.

Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table F

Total energy consumption in the mining sector was approximately 670 petajoules in 2016–17, up 12 per cent on the previous year (Table 2.6). Much of this was due to growth in natural gas used for liquefaction at LNG plants in Queensland and Western Australia (Figure 2.6). In 2016–17, own-use natural gas consumption at Australia's LNG facilities increased to 239 petajoules, supporting growth of LNG exports from 37 to 52 million tonnes.

Table 2.6: Australian mining energy consumption, by subsector

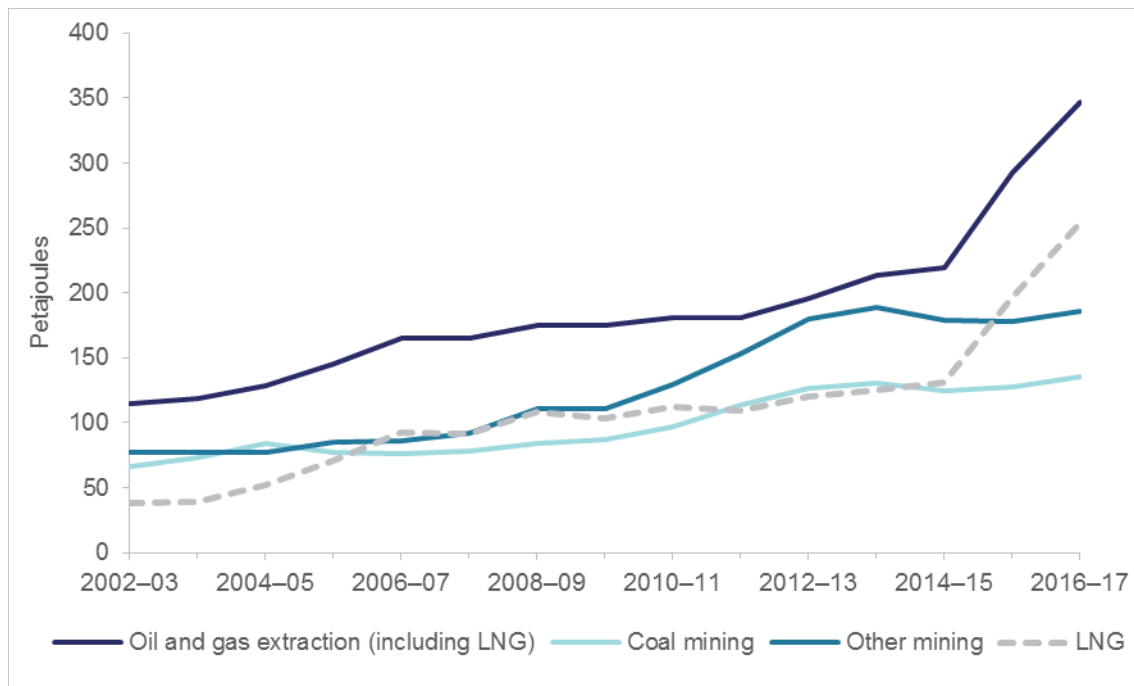
	2016–17		Average annual growth	
	PJ	share (per cent)	2016–17 (per cent)	10 years (per cent)
Oil and gas	346.6	51.8	18.4	8.6
- LNG	253.5	37.9	29.2	11.9
Coal	136.0	20.3	6.6	6.4
Other mining	186.3	27.9	4.7	8.2
<b>Total</b>	<b>669.0</b>	<b>100.0</b>	<b>11.8</b>	<b>8.0</b>

Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table F.

This excludes gas used for electricity generation at the processing and liquefaction plants, which is included in the electricity generation sector of the AES. The mining sector includes electricity consumption at these facilities, which also increased strongly in 2016–17.

Other parts of the mining sector also recorded large increases in energy use in 2016–17. In particular, there was an increase in diesel consumption in Queensland’s coal mining industry and in Western Australia’s other mining industry as commodity prices recovered over this period. Iron ore production increased by 4 per cent in 2016–17 (Department of Industry, Innovation and Science 2018).

Figure 2.6: Australian energy consumption in mining



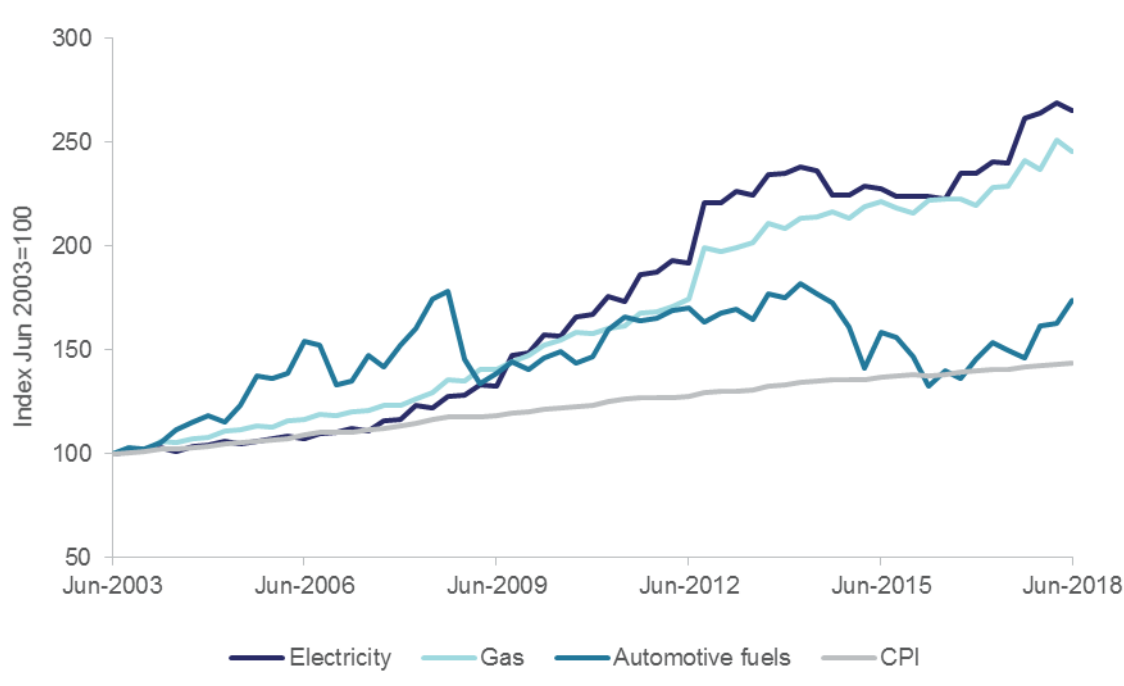
Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table F and internal sources

Commercial and services energy consumption rose moderately by 2 per cent in 2016–17. This is attributable to growth in activity in the sector, with industry value added across the commercial sector up by 4 per cent in that year (ABS 2018b).

Energy consumption in the residential sector was relatively flat in 2016–17. Consumption in the residential sector includes the use of electricity generated from rooftop solar photovoltaic (PV) systems. In recent years, residential energy consumption has been relatively flat or in decline in response to higher electricity prices and adoption of more energy efficient practices, appliances and housing. Retail electricity prices for households in 2016–17 rose by 6 per cent and by almost 12 per cent in 2017–18 (Figure 2.7).

In the agriculture sector, energy use increased nearly 6 per cent in 2016–17. A record winter harvest in 2016–17 increased diesel demand for cropping, with winter crop production 50 per cent higher in 2016–17 (ABARES 2018).

Figure 2.7: Quarterly household energy price index



Source: Australian Bureau of Statistics (2018c) *Consumer Price Index, Australia, June 2018*, 6401.1

## 2.4 Final energy consumption

Final energy consumption is the energy used by the final or end-use sectors, and is a subset of total energy consumption. It includes all energy consumed, except energy that is used to convert or transform primary energy into different forms of energy. For example, refinery feedstock that is used to produce petroleum products and fuels consumed in the generation of electricity are both excluded.

Table 2.7: Australian total final energy consumption, by fuel

	2016–17		Average annual growth	
	PJ	share (per cent)	2016–17 (per cent)	10 years (per cent)
Coal	121.3	2.9	5.8	-3.7
Refined products	2,197.0	51.7	2.4	1.7
Gas	910.9	21.4	3.9	2.4
Electricity	820.3	19.3	0.1	0.9
Renewables	197.8	4.7	5.1	3.8
<b>Total</b>	<b>4,247.2</b>	<b>100.0</b>	<b>2.5</b>	<b>1.6</b>

Notes: Excludes fuels used for electricity generation and other conversion.

Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table H

Table 2.8: Australian total final energy consumption, by industry

	2016–17		Average annual growth	
	PJ	share (per cent)	2016–17 (per cent)	10 years (per cent)
Agriculture	116.3	2.7	6.0	2.3
Mining	669.0	15.8	11.8	8.0
Manufacturing	910.4	21.4	-2.1	-1.1
Construction	24.2	0.6	-0.5	-0.9
Transport	1,678.3	39.5	2.8	1.7
Commercial	344.6	8.1	1.7	2.0
Residential	458.4	10.8	-0.5	0.7
Other	46.0	1.1	-5.8	-3.5
<b>Total</b>	<b>4,247.2</b>	<b>100.0</b>	<b>2.5</b>	<b>1.6</b>

Notes: Energy consumption in some sectors differs from Table 3.3 due to exclusion of energy used in conversion activities.

Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table H

Final energy consumption in 2016–17 increased by 3 per cent, which is above the ten year average growth rate of 2 per cent (Table 2.7). In 2016–17, refined products accounted for more than half of Australia’s final energy consumption, followed by electricity and natural gas.

## 2.5 Energy use, by state and territory

In 2016–17, most growth in energy use was in Western Australia and Queensland, while energy use in Victoria and South Australia fell (Table 2.9).

Energy consumption in Western Australia rose by 5 per cent in 2016–17. Nearly all of this growth was in the mining sector, with consumption in most other sectors nearly flat. Queensland energy consumption grew by 4 per cent, with the largest increases in energy use in mining, manufacturing, electricity generation and transport.

In Victoria, energy consumption fell 2 per cent in 2016–17, reflecting the decline in brown coal consumption for electricity generation after the closure of Hazelwood (Figure 2.8). South Australian energy consumption fell by 9 per cent in 2016–17, some of which was also attributable to the closure of coal-fired electricity generation capacity in South Australia.

In New South Wales, energy consumption grew by 1 per cent in 2016–17. This growth was concentrated in the transport sector, with aviation turbine fuel contributing around half of total growth. Tasmanian energy consumption also rose slightly in 2016–17.

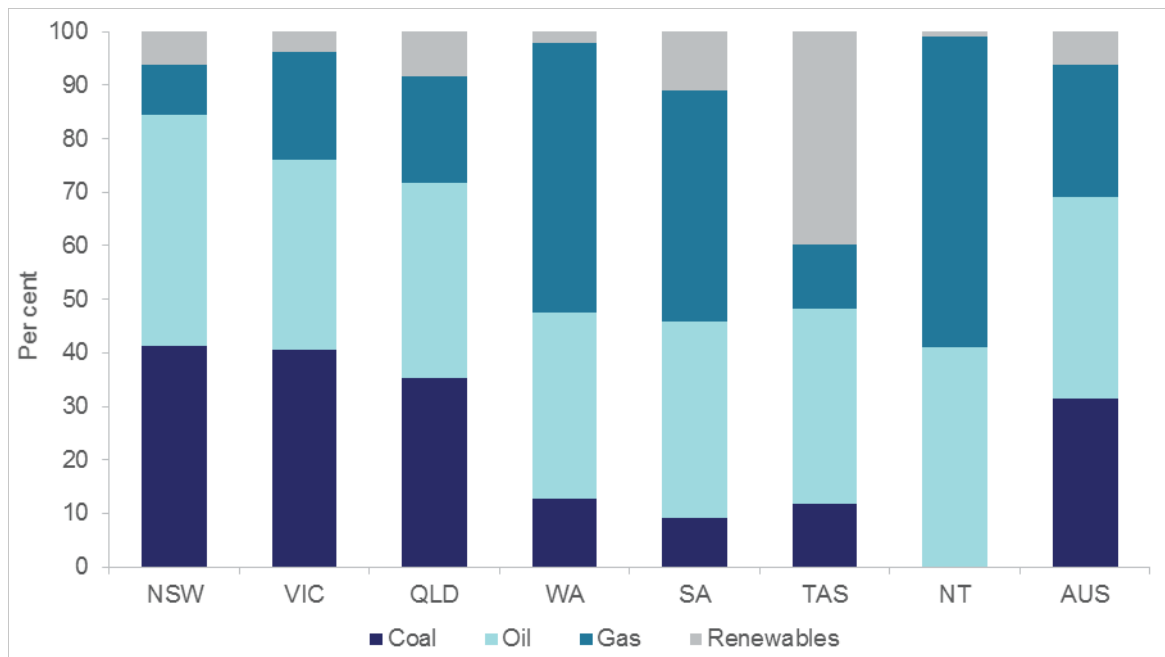
Table 2.9: Australian energy consumption, by state and territory

	2016–17		Average annual growth	
	PJ	share (per cent)	2016–17 (per cent)	10 years (per cent)
New South Wales <sup>a</sup>	1,530.6	24.9	1.0	-0.6
Victoria	1,404.3	22.8	-2.2	-0.2
Queensland	1,533.8	25.0	3.5	1.9
Western Australia	1,179.5	19.2	5.0	4.0
South Australia	304.7	5.0	-8.6	-2.2
Tasmania	109.8	1.8	0.8	-0.6
Northern Territory	83.1	1.4	-0.2	-1.6
<b>Total</b>	<b>6,145.8</b>	<b>100.0</b>	<b>1.1</b>	<b>0.8</b>

Notes: <sup>a</sup> Includes Australian Capital Territory

Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table C

Figure 2.8: Australian energy mix, by state and territory, 2016–17



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table C



## 3. Energy production

### 3.1 Primary production

Energy production is defined as the total amount of primary energy produced in the Australian economy, measured before consumption or transformation. Forms of renewable energy that produce electricity directly without a thermal component, such as wind, hydro and solar PV, are considered primary energy sources. Coal-fired electricity generation is considered secondary energy production and is not included, as the coal is already accounted for when mined.

Domestic production of primary energy increased by 4 per cent in 2016–17, to reach 17,957 petajoules (Table 3.1). This is consistent with the trend in energy production over the past decade (Figure 3.1), which has seen production become more export-oriented. Australia is a net exporter of energy, including coal and natural gas, with net exports equal to around two-thirds of production (Figure 3.2). Australia also produces and exports large volumes of uranium oxide.

A decline in Queensland black coal production was offset by an increase in New South Wales production, leaving overall black coal production steady in 2016–17, at 12,154 petajoules (443 million tonnes). Australian production peaked at 12,288 petajoules (447 million tonnes) in 2014–15.

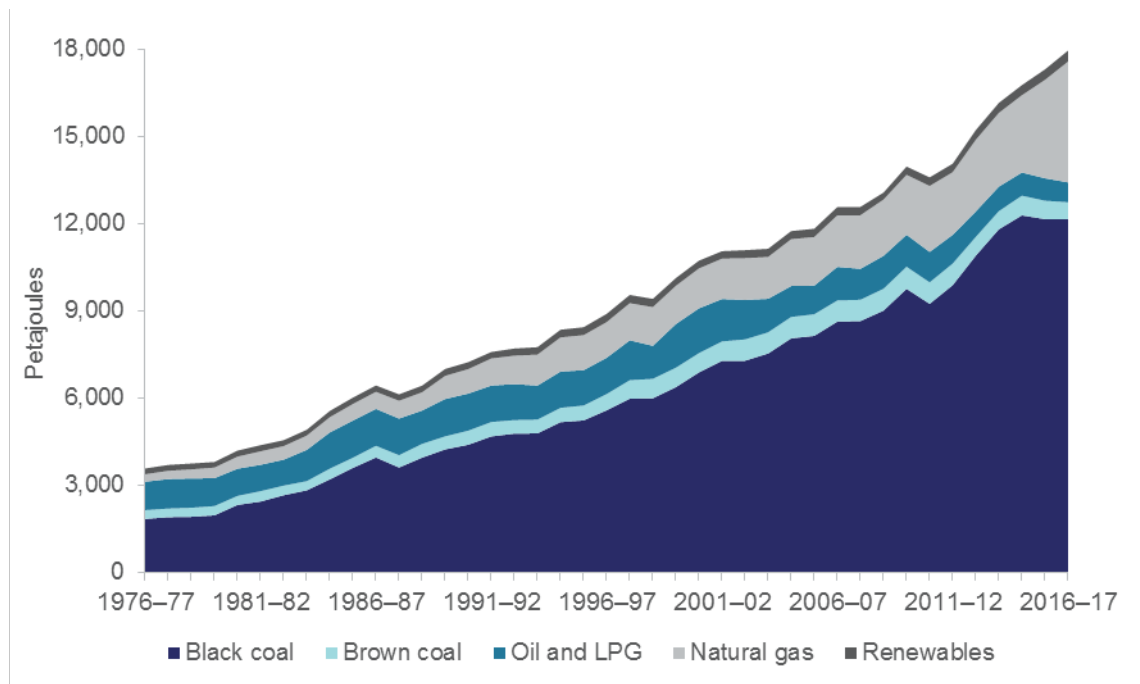
Brown coal production fell in 2016–17, by 8 per cent to 584 petajoules (57 million tonnes). Virtually all brown coal produced in Australia is used for electricity generation. The level of production is now around 23 per cent lower than peak production in 2009–10. The fall in production is largely due to the closure of the closure of Hazelwood power station in early 2017 and Northern power station in May 2016.

Table 3.1: Australian energy production, by fuel type

	2016–17		Average annual growth	
	PJ	share (per cent)	2016–17 (per cent)	10 years (per cent)
Black coal	12,154.4	67.7	0.0	3.9
Brown coal	584.2	3.3	-8.0	-2.5
Natural gas	4,154.8	23.1	22.7	9.4
Oil and NGL	596.9	3.3	-12.3	-5.1
LPG	88.1	0.5	-2.4	-2.2
Renewables	378.7	2.1	5.3	3.2
<b>Total</b>	<b>17,957.1</b>	<b>100.0</b>	<b>3.7</b>	<b>4.0</b>

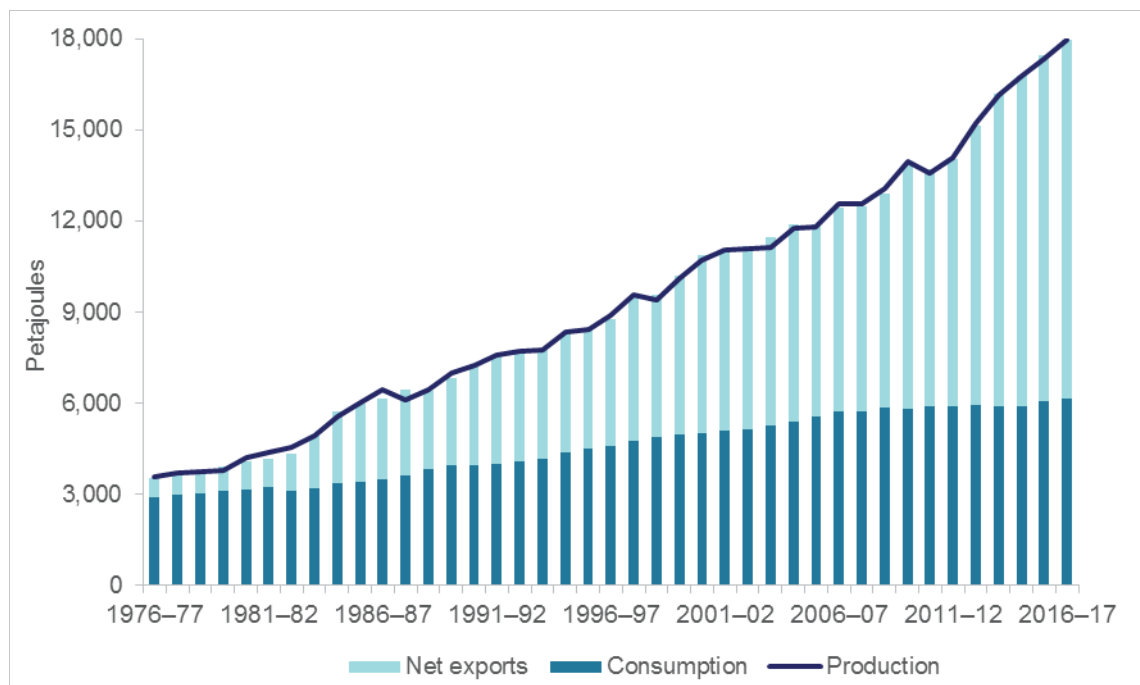
Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table J

Figure 3.1: Australian energy production, by fuel type



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table J

Figure 3.2: Australian energy balance



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table J

Natural gas production rose by 23 per cent in 2016–17 to 4,155 petajoules (106 billion cubic metres) to support additional LNG export capacity in Queensland and Western Australia. Western Australia remained Australia's largest producer of natural gas, producing roughly half of total gas production in 2016–17. Queensland accounted for 34 per cent of total production in that year. Queensland gas production of 1,328 petajoules (35 billion cubic metres) in 2016–17 was nearly four times what it was in 2013–14.

Production of coal seam gas increased significantly in 2016–17 to reach 1,290 petajoules (34 billion cubic metres). Coal seam gas accounted for one-third of Australian gas production on an energy content basis, and nearly two-thirds of east coast gas production in 2016–17.

Australia produced 597 petajoules (16 billion litres) of crude oil and natural gas liquids in 2016–17, a decline of 12 per cent relative to the previous year. A fall in output occurred across all producing states and territories, attributable to continued declines in production at mature fields.

Renewable energy production increased by 5 per cent in 2016–17 to reach 379 petajoules. Major sources that increased production included bagasse, wind, hydro and solar electricity generation. Renewable energy accounted for just over 2 per cent of total energy production in 2016–17, similar to its share in recent years.

Australia also produces uranium oxide, which is exported for use in nuclear power plants overseas. Uranium production decreased 18 per cent in 2016–17 to 7,081 tonnes, which is equivalent to 3,328 petajoules. This reflects the closure of Olympic Dam during 2017 for upgrades. Uranium oxide is not included in the total primary energy production. Instead, the heat content of the steam leaving the nuclear reactor for the turbine is counted, which is not applicable for Australia.

### 3.2 Electricity generation

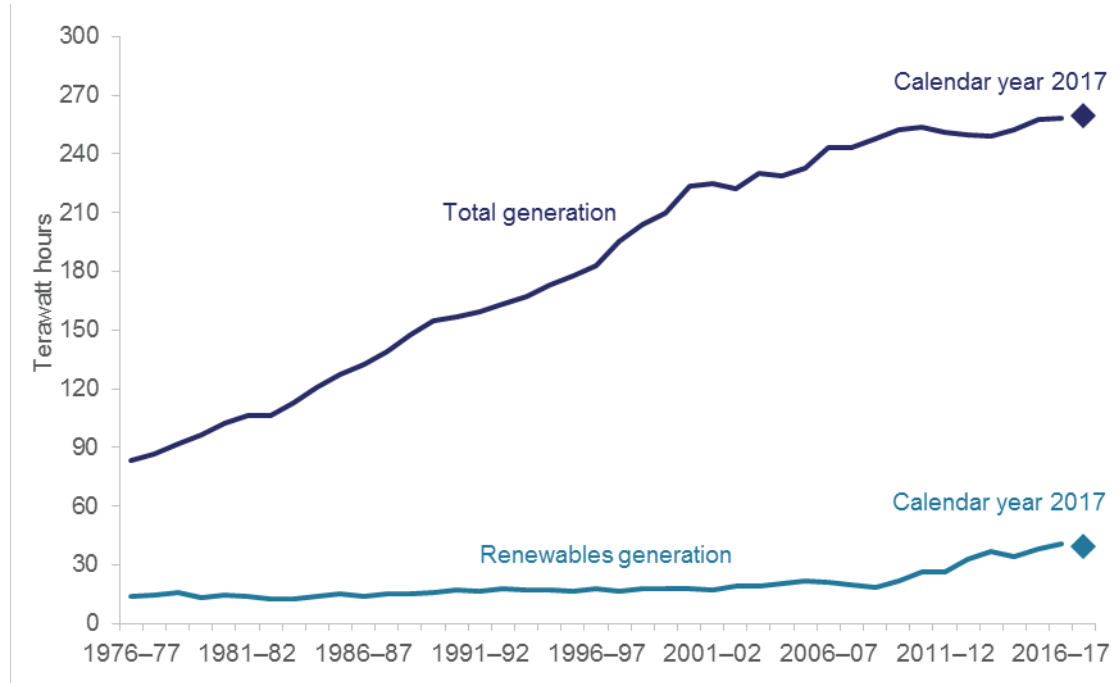
In 2016–17 total electricity generation in Australia was relatively stable, increasing by just by 0.2 per cent, after growing by 2 and 1 per cent in the preceding two years respectively. This followed three consecutive years of decline (Figure 3.3). Total electricity generation was 258 terawatt hours (929 petajoules) in 2016–17, the highest total generation on record for Australia.

This figure captures all electricity generation in Australia. In addition to power plants, it includes rooftop solar PV generation, generation by industrial facilities such as in mining and manufacturing, and off-grid generation. About 12 per cent of Australia's electricity was generated by industry and households. This share varies considerably across state and territories, including contributing over one-third of total generation in Western Australia (Figure 3.4). This figure is estimated using the industry classification reported by the facility, and does not differentiate if it is on or off grid.

Electricity generation decreased in 2016–17 in South Australia (by 10 per cent), Victoria (by 3 per cent) and the Northern Territory (by 2 per cent), but increased in all other states and territories. This decline reflects the closure of Hazelwood

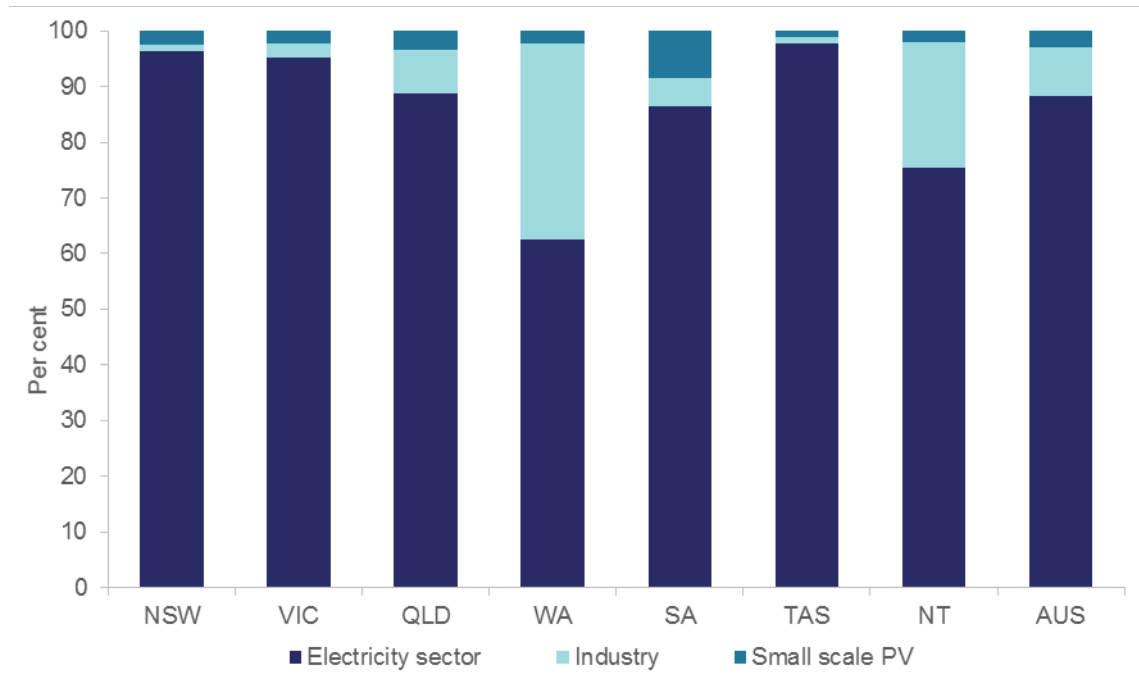
brown coal fired power station in Victoria in March 2017, and exit of coal fired power in South Australia after the closure of Northern Power Station in 2016.

Figure 3.3: Australian electricity generation



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table O and L

Figure 3.4: Australian electricity generation, by industry, 2016-17

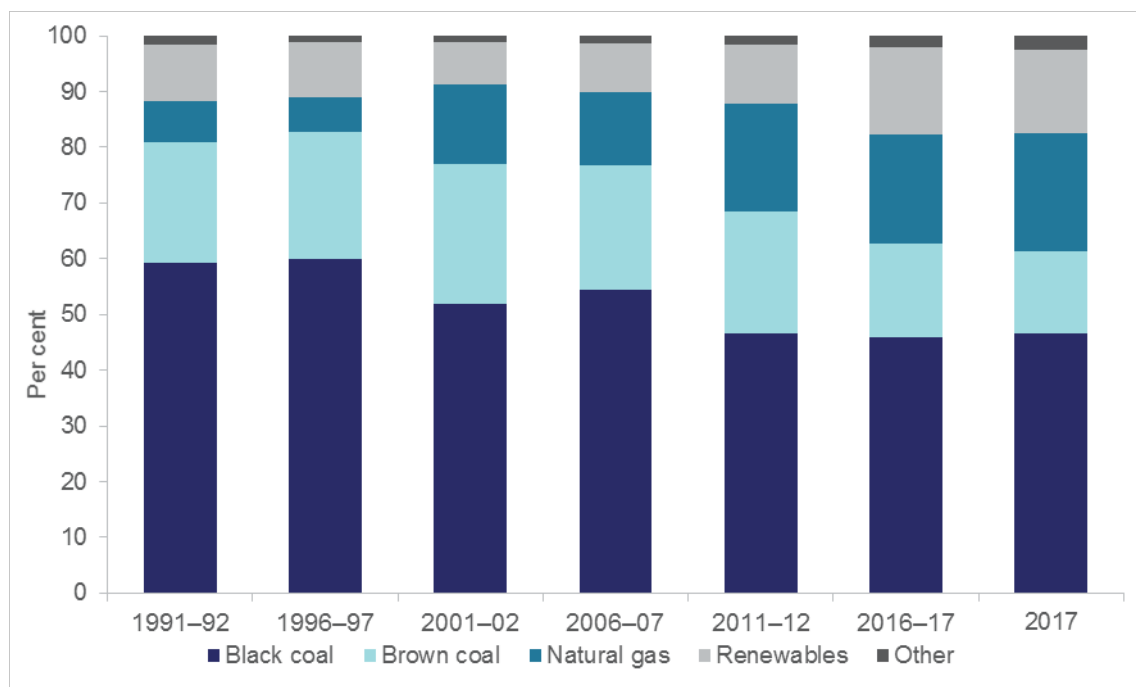


Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table O

Coal remained the major source for electricity generation in 2016–17, with its share in the fuel mix remaining at 63 per cent (Table 3.2). Coal's share of the electricity generation mix remains well below its share of more than 80 per cent at the beginning of the century (Figure 3.5).

Coal-fired generation increased in New South Wales, Western Australia and Queensland in 2016–17, with black coal-fired generation rising by 3 per cent. However, brown coal-fired generation declined by 11 per cent in 2016–17, leading to an overall decline in coal-fired generation of 1 per cent. This reverses the increase in coal-fired generation in Australia in 2014–15 and 2015–16, and returns to the previous trend of decline. The decline in brown coal use in 2016–17 reflects the recent closure of capacity in South Australia and Victoria.

Figure 3.5: Australian electricity generation fuel mix



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table O

Natural gas-fired generation decreased by 0.2 per cent in 2016–17, and continued to account for about 20 per cent of Australia's electricity generation. Gas-fired generation fell in some states and territories, but rose in Victoria, Western Australia and South Australia.

Oil-fired generation decreased significantly in 2016–17 and sits at 2 per cent of Australia's electricity generation. This decline largely occurred in Western Australia, where gas generation grew instead of oil.

Renewable energy accounted for 16 per cent of Australia's electricity generation in 2016–17. Renewable generation increased by 6 per cent in 2016–17, driven by increases in solar, hydro, and wind, which increased by 18 per cent, 6 per cent, and 3 per cent respectively.

Hydro continues to be the largest contributor to renewable generation, with a 40 per cent share of renewable generation in 2016–17. This compares with

95 per cent in 2000–01, with the composition of renewable energy in Australia diversifying significantly as wind and increasingly solar capacity has come online (Figure 3.5).

Table 3.2: Australian electricity generation, by fuel type

	2016–17		Average annual growth	
	GWh	share (per cent)	2016–17 (per cent)	10 years (per cent)
<b>Fossil fuels</b>	<b>217,562</b>	<b>84.3</b>	<b>-0.8</b>	<b>-0.3</b>
Black coal	118,272	45.8	3.5	-1.0
Brown coal	43,558	16.9	-10.7	-2.5
Gas	50,460	19.6	-0.2	4.2
Oil	5,273	2.0	-6.8	3.0
<b>Renewables</b>	<b>40,455</b>	<b>15.7</b>	<b>6.1</b>	<b>8.2</b>
Hydro	16,285	6.3	6.3	3.4
Wind	12,597	4.9	3.3	16.9
Bioenergy	3,501	1.4	-7.6	-3.0
- bagasse	1,435	0.6	-20.7	na
- wood, woodwaste	355	0.1	42.7	na
- municipal, industrial waste	76	0.0	76.9	na
- sulphite lyes, biofuels	442	0.2	6.2	na
- landfill biogas	970	0.4	-8.6	na
- sludge biogas	223	0.1	5.6	na
Solar PV	8,072	3.1	18.0	59.2
- small scale	7,399	2.9	16.0	57.7
- large scale	672	0.3	47.1	na
Geothermal	1	0.0	133.3	na
<b>Total</b>	<b>258,017</b>	<b>100</b>	<b>0.2</b>	<b>0.7</b>

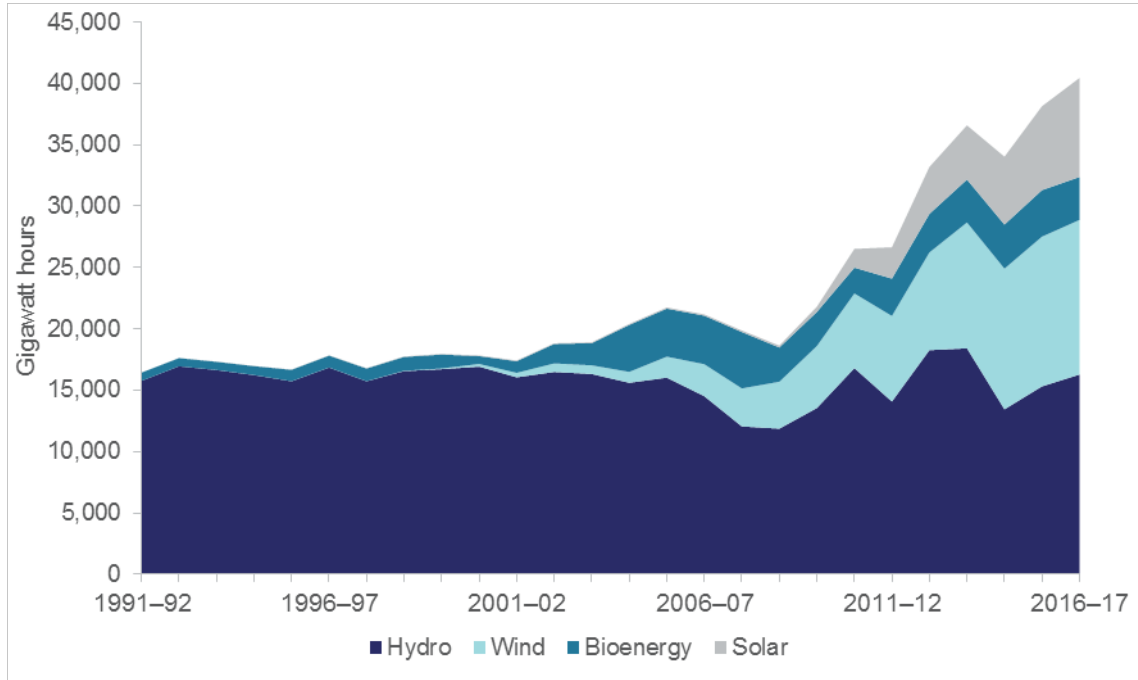
Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table O

Wind contributed 31 per cent of renewable electricity in 2016–17 and 5 per cent of total electricity generation in Australia. Wind generation rose by 3 per cent in 2016–17. Wind generation continues to be particularly prevalent in South Australia, accounting for over one-third of the total generation mix in that state for the past two years.

Solar generation continued to grow strongly in 2016–17, by 18 per cent, and accounted for 3 per cent of total electricity generation in Australia. Growth in large scale installations remained strong at 47 per cent. This growth largely came from existing facilities ramping up production, after the introduction of several new facilities in the previous year. However, this growth was from a small base, and small scale rooftop solar PV installations continue to make up the vast majority of total solar generation in Australia.

Among bioenergy sources, generation from bagasse during 2016–17 was lower than the previous year, with more bagasse being used by the food manufacturing sector for other stationary energy purposes.

Figure 3.6: Australian electricity generation from renewable sources



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table O

### 3.3 Electricity generation in calendar year 2017

Estimates of electricity generation were published in May 2018 for the 2017 calendar year, to improve the availability of up-to-date official data on total generation in Australia. Total electricity generation in Australia was estimated to be 259 terawatt hours in calendar year 2017, an increase of approximately 1 per cent compared with 2016 (Table 3.3).

Non-renewable sources contributed 220 terawatt hours (85 per cent) of total electricity generation in 2017, a decrease of 1.4 per cent compared with 2016. Coal continued to account for the majority of electricity generation, at 61 per cent of total generation in 2017. Gas-fired generation increased in 2017, to represent 21 per cent of total generation.

Renewable sources contributed 39 terawatt hours, or about 15 per cent of total electricity generation in 2017. The largest source of renewable generation was hydro (5 per cent of total generation), followed by wind (5 per cent) and small-scale solar (3 per cent). Renewable generation decreased by 7 per cent in 2017 from 42 terawatt hours in 2016, with a steep decline in hydro generation and slight drop in wind generation offsetting growth in other sources.

Generation varies quite a lot across Australia. In 2017, more than 70 per cent of electricity generation in Queensland, New South Wales and Victoria was coal fired (Figure 3.7). In Victoria, brown coal's share was 77 per cent in 2017, down from 84 per cent in 2016. This is largely attributable to the closure of

Hazelwood in early 2017. Gas accounted for the majority of generation in Western Australia and the Northern Territory, and Western Australia accounted for 40 per cent of Australia's gas-fired generation in 2017.

Renewable energy's share was 87 per cent in Tasmania and 43 per cent in South Australia in 2017. In Tasmania, this was mainly hydro, while in South Australia wind accounted for 35 per cent of generation. South Australia accounted for a little over one-third of total wind generation in Australia. Victoria also accounted for nearly 30 per cent of total wind generation.

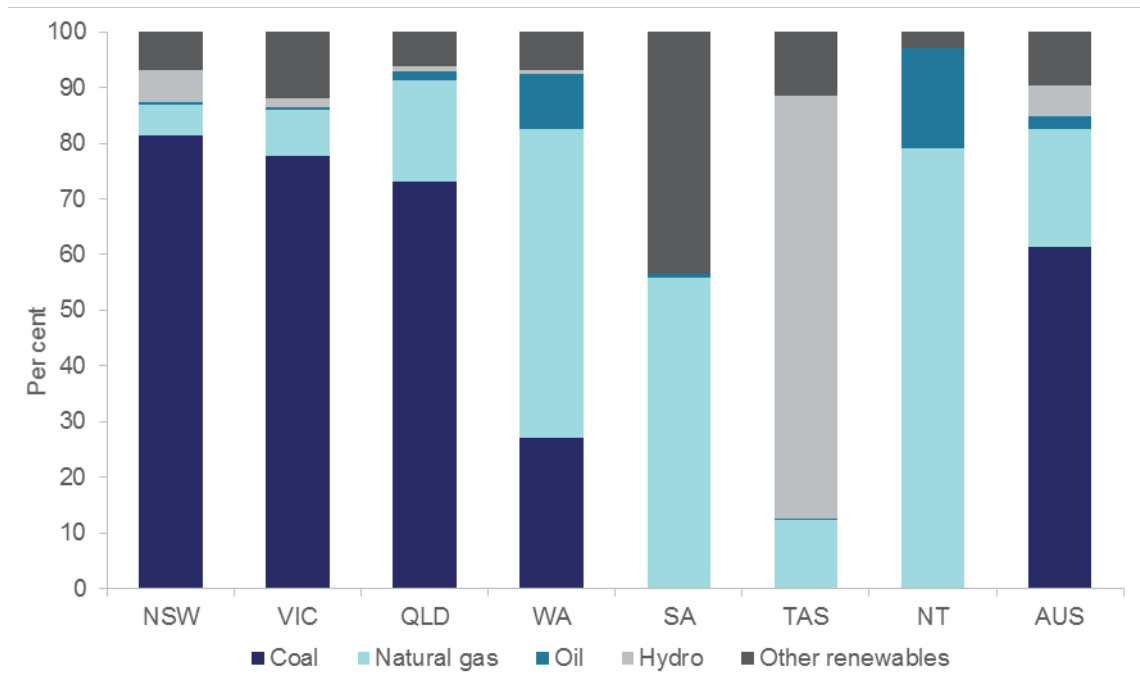
Table 3.3: Australian electricity generation, by fuel type, calendar year 2017

	2017	
	GWh	share (per cent)
<b>Fossil fuels</b>	<b>220,359</b>	<b>84.9</b>
Black coal	120,832	46.6
Brown coal	38,313	14.8
Gas	54,929	21.2
Oil	6,285	2.4
<b>Renewables</b>	<b>39,087</b>	<b>15.1</b>
Hydro	13,933	5.4
Wind	12,668	4.9
Bioenergy	3,637	1.4
Solar PV small scale	8,082	3.1
Solar PV large scale	766	0.3
Geothermal	1	0.0
<b>Total</b>	<b>259,446</b>	<b>100.0</b>

Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table O



Figure 3.7: Australian electricity generation fuel mix, calendar year 2017



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table O

## 4. Energy trade

### 4.1 Exports

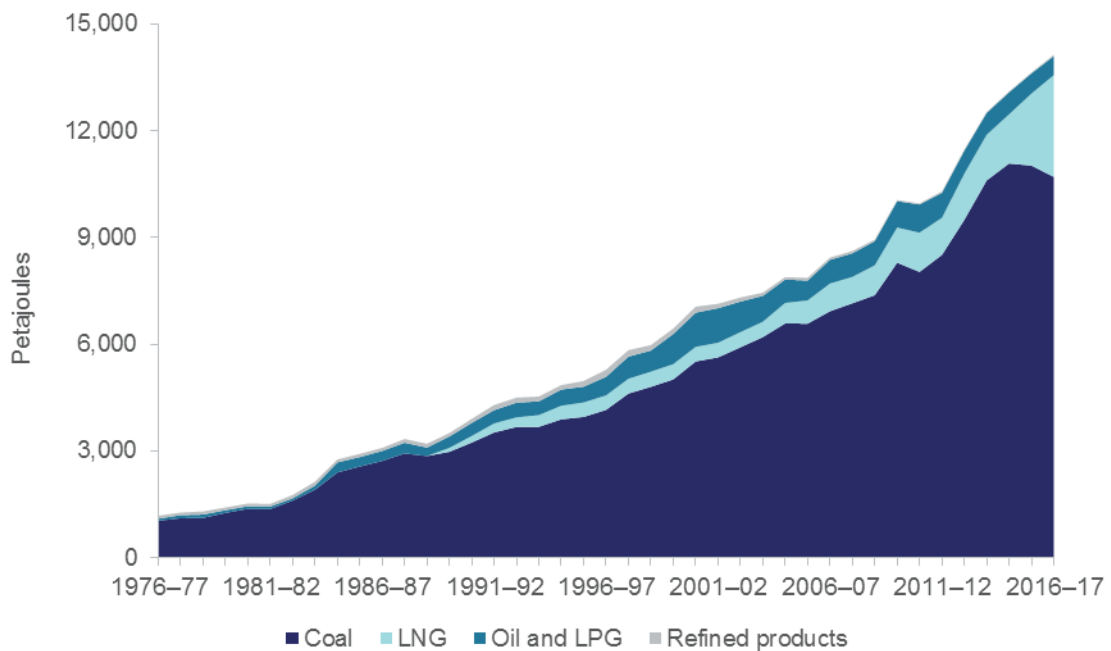
Australia exports a significant proportion of its energy production. Around 88 per cent of black coal production was exported in 2016–17, as was around 69 per cent of natural gas production and 79 per cent of crude oil production. Australia’s energy exports rose by 4 per cent in 2016–17 to reach 14,140 petajoules, supported by a large increase in LNG exports (Table 4.1; Figure 4.1).

Table 4.1: Australian energy exports, by fuel type

	2016–17		Average annual growth	
	PJ	share (per cent)	2016–17 (per cent)	10 years (per cent)
Black coal	10,685.8	75.6	-2.9	4.6
Coal by-products	15.9	0.1	-22.2	na
LNG	2,864.5	20.3	41.4	16.2
Crude oil	473.7	3.4	-7.8	-2.4
LPG	60.3	0.4	12.2	-1.6
Refined products	39.9	0.3	71.1	-5.5
<b>Total</b>	<b>14,140.1</b>	<b>100.0</b>	<b>3.7</b>	<b>5.6</b>

Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table J

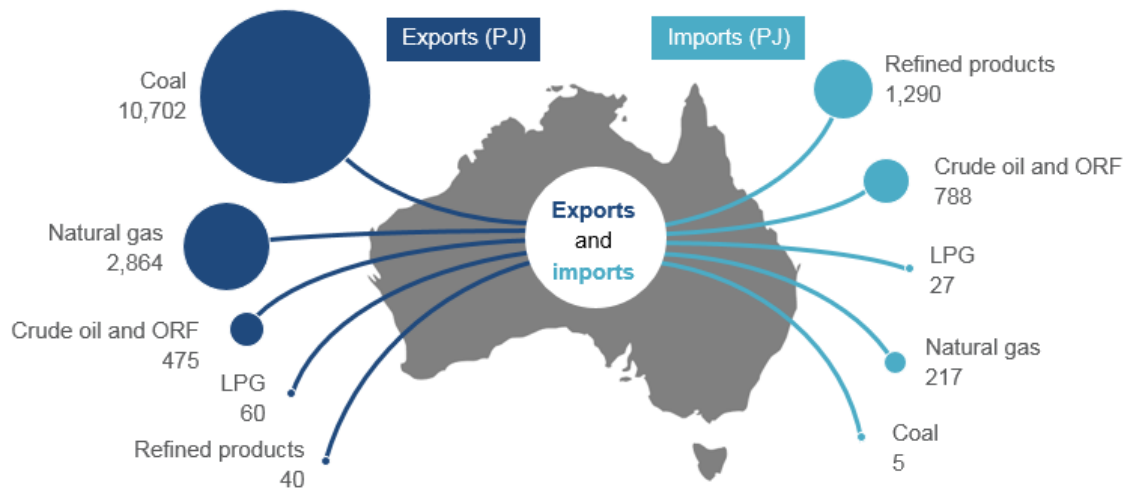
Figure 4.1: Australian energy exports, by fuel type



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table J

Black coal remains Australia's largest energy export in energy content terms. (Figure 4.2). Exports of black coal fell by 3 per cent in 2016–17 in energy content terms, to 10,686 petajoules (around 379 million tonnes), reflecting lower demand from major trading partners. On average, coal exports have grown by 5 per cent a year over the past decade.

Figure 4.2: Australian energy trade, 2016–17



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table J

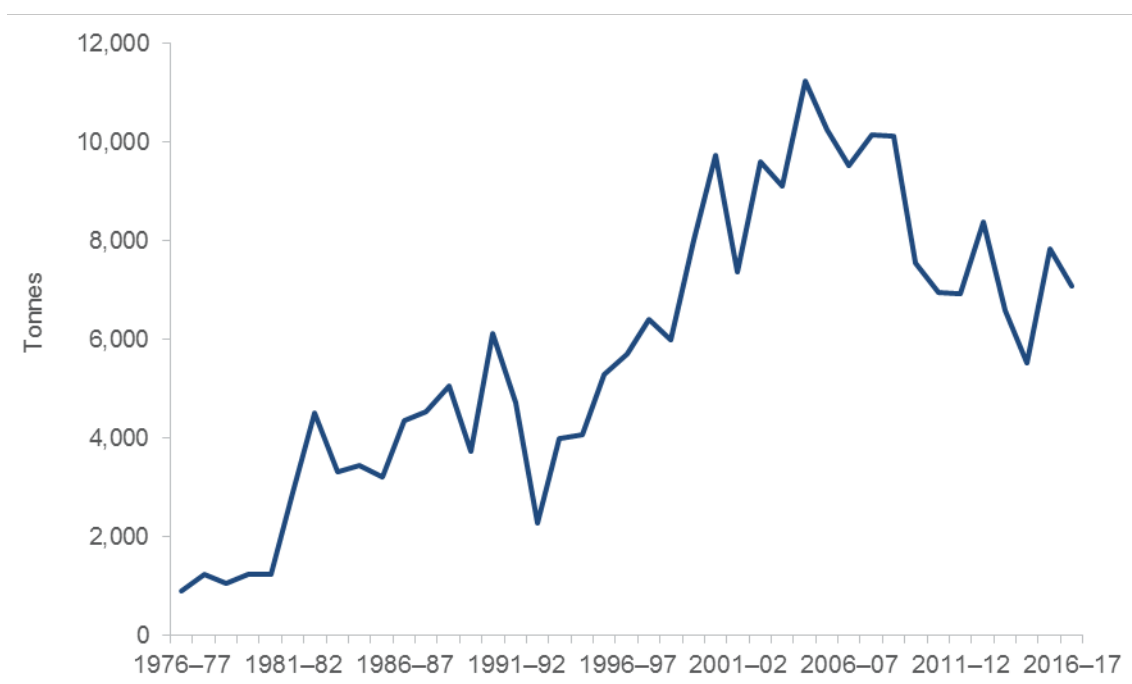
LNG exports increased by 41 per cent in 2016–17, to 2,865 petajoules (around 52 million tonnes), as new export capacity came online in Queensland and Western Australia. Exports of LNG have increased by an average of 16 per cent a year over the past decade, with several new facilities commencing production.

Crude oil exports fell by 8 per cent in 2016–17 to 474 petajoules (13 billion litres), roughly in line with decline in domestic production. Australia also exports a small volume of refined products. Petrol and fuel oil exports increased strongly in 2016–17, but refined product exported remain a relatively small proportion of local production.

Australia also exports large volumes of uranium oxide, which is enriched overseas for use in nuclear power plants. Australia accounted for 11 per cent of world uranium production in 2016–17 and is one of the world's largest exporters. Uranium oxide is not included a country's energy balance. Instead, the heat content of the steam leaving the nuclear reactor for the turbine is counted, which is not applicable for Australia.

Uranium exports declined by 5 per cent in 2016–17, to 7,081 tonnes, which has an energy content of around 3,328 petajoules (Figure 4.3). This reflects closure of Olympic Dam during 2017 for upgrades. While Australia exports all of its uranium production, production and export figures can differ due to stockpiling.

Figure 4.3: Australian uranium exports



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table S

## 4.2 Imports

Australia's energy imports increased by 2 per cent in 2016–17 to 2,327 petajoules, although as with recent years, this masked large movements in individual fuels (Table 4.2).

Refined products and crude oil are by far Australia's largest energy imports (Figure 4.4), with the majority of consumption of these commodities met by imports. Natural gas from the Joint Petroleum Development Area in the Timor Sea, which is liquefied at Darwin before being re-exported, was the third largest energy import.

Table 4.2: Australian energy imports, by fuel type

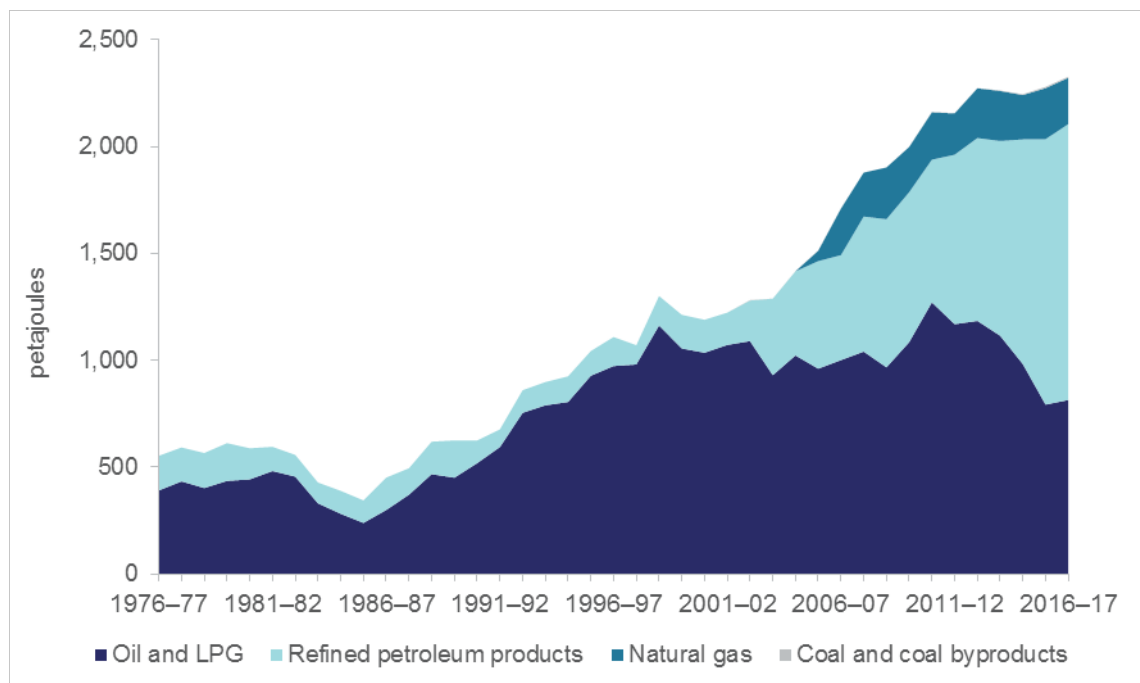
	2016–17		Average annual growth	
	PJ	share (per cent)	2016–17 (per cent)	10 years (per cent)
Crude oil	787.7	33.8	2.5	-2.8
LPG	27.1	1.2	9.2	0.4
Refined products	1,290.5	55.5	3.9	8.3
Natural gas	216.7	9.3	-9.1	0.6
Coal and coal byproducts	5.0	0.2	-16.5	41.5
<b>Total</b>	<b>2,327.0</b>	<b>100.0</b>	<b>2.1</b>	<b>2.4</b>

Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table J

Imports of crude oil increased by 3 per cent in 2016–17, to 788 petajoules (around 20 billion litres). Australia imports a relatively large proportion of its refinery feedstocks, with most of Australia’s oil production occurring off the north-west coast, some distance from most domestic refining capacity on the east coast. In addition, domestically produced grades of crude oil are generally not as well suited for use by local refineries as those sourced from other countries. Imports accounted for just under three-quarters of total refinery input in 2016–17 (Figure 4.5).

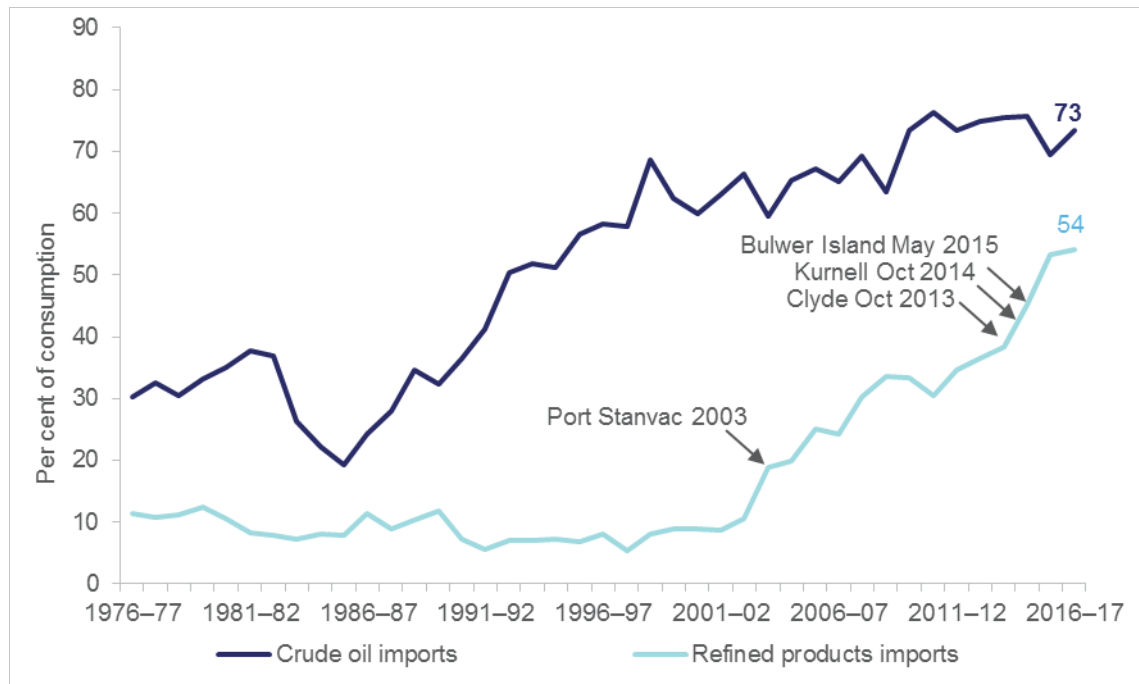
Refined product imports, excluding LPG, rose by 4 per cent to 1,291 petajoules (around 35 billion litres) in 2016–17. This continues the longer-term trend towards imported refined products, following the closure of several domestic refineries. Imported products now account for around 54 per cent of total refined product consumption.

Figure 4.4: Australian energy imports, by fuel type



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Table J

Figure 4.5: Share of imports in total consumption of crude and refined products



Source: Department of the Environment and Energy (2018) *Australian Energy Statistics*, Tables J and D

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